



## NASA SBIR 2012 Phase I Solicitation

### H2.02 In-Space Propulsion Systems

Lead Center: GRC

Participating Center(s): JSC, MSFC

OCT Technology Area: [TA02](#)

This solicitation intends to examine a range of key technology options associated with cryogenic, non-toxic storable, and solid core nuclear thermal propulsion (NTP) systems for use in future exploration missions.

Non-toxic engine technology, including new mono and bipropellants, is desired for use in lieu of the currently operational NTO/MMH engine technology. Handling and safety concerns with toxic chemical propellants can lead to more costly propulsion systems. NTP systems using nuclear fission reactors may enable future short round trip missions to Mars, by helping to reduce launch mass to reasonable values and thereby increasing the payload delivered for Mars exploration missions.

Non-toxic and cryogenic engine technologies could range from pump fed or pressure fed reaction control engines of 25-1000 lbf up to 60,000 lbf primary propulsion engines. Pump fed NTP engines in the 15,000-25,000 lbf class, used individually or in clusters, would be used for primary propulsion.

Specific technologies of interest to meet proposed engine requirements include:

- Non-toxic bipropellant or monopropellants that meet performance targets (as indicated by high specific impulse and high specific impulse density) while improving safety and reducing handling operations as compared to current state-of-the-art storable propellants.
- Manufacturing techniques that lower the cost of manufacturing complex components such as injectors and coolant channels. Examples include, but are not limited to, development and demonstration of rapid prototype techniques for metallic parts, powder metallurgy techniques, and application of nano-technology for near net shape manufacturing.

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- High temperature materials, coatings and/or ablatives or injectors, combustion chambers, nozzles, and nozzle extensions.
  - Long life, lightweight, reliable turbo-pump designs and technologies include seals, bearing and fluid system components. Hydrogen technologies are of particular interest.
  - Highly-reliable, long-life, fast-acting propellant valves that tolerate long duration space mission environments with reduced volume, mass, and power requirements is also desirable.
  - High temperature, low burn-up carbide- and ceramic-metallic (cermet) based nuclear fuels with improved coatings and/or claddings to maximize hydrogen propellant heating and to reduce fission product gas release into the engine's hydrogen exhaust stream.
  - High temperature and cryogenic radiation tolerant instrumentation and avionics for engine health monitoring. Non-invasive designs for measuring neutron flux (outside of reactor), chamber temperature, operating pressure, and liquid hydrogen propellant flow rates over wide range of temperatures are desired. Sensors need to operate for months/years instead of hours.

Note to Proposer: Subtopic S3.03 under the Science Mission Directorate also addresses in-space propulsion. Proposals more aligned with science mission requirements should be proposed in S3.03.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II demonstration, and delivering a demonstration package for NASA testing at the completion of the Phase II contract.

*Phase I Deliverables* - Research to identify and evaluate candidate technology applications to demonstrate the technical feasibility and show a path towards a demonstration. Bench or lab-level demonstrations are desirable. The technology concept at the end of Phase I should be at a TRL range of 3-4.

*Phase II Deliverables* - Emphasis should be placed on developing and demonstrating the technology under simulated mission conditions. The proposal shall outline a path showing how the technology could be developed into mission-worthy systems. The contract should deliver a demonstration unit for functional and environmental testing at the completion of the Phase II contract. The technology concept at the end of Phase II should be at a TRL range of 4-6.

Potential NASA Customers include:

- Office of Chief Technologist/Game Changing Development Program - In-Space Propulsion Project.
- Office of Chief Technologist/Game Changing Development Program - Manufacturing Innovation (MIP).
- Cryogenic Propulsion Stage/Advanced Upper Stage Engine Program.
- Human Exploration and Operations Directorate/Advanced Exploration Systems - Nuclear Cryogenic Propulsion Stage.

